LPPDE

CPS (Cyber & Physical System)-Platform
for LEAN product development

Takashi Tanaka

April 27th, 2023

KYUSHU
UNIVERSITY

Takashi Tanaka: Specialist of CPS-Platform

■ Current:

- Kyushu University, Guest Lecturer

■ History:

- Mitsubishi UFJ Research and Consulting Co., Ltd.
- PwC Consulting LLC
  A&D (Airplane & Defense)
- KPMG Consulting
  Manufacturing
- Dassault Systemes KK
  PMO for automobile Platform development
- Toyota Engineering Co. Ltd
  Applied TMS (Toyota management system)

■ Introduction:

I have had extensive experiences of TMS (Toyota Management System) and have applied in many global manufactures such as automobile, aviation, and other industries.
I also have deep knowledge as PMO for automobile and aviation platform development.

In addition, I have been working on BtoB Platform development using 5G, cloud, and AI/ML (Machine learning) to accomplish DX.
I have built up experience and expertise in Quantum computing integrated with current computer.

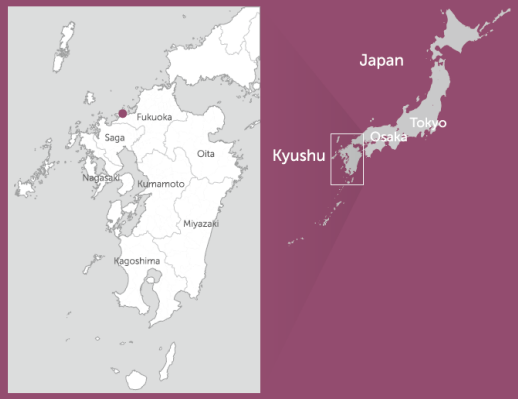
Currently I am working for developing CPS-Platform for university as a bridge between industry.

Introduction of Kyushu University

History

- Nov. 2021 Selected as a Designated National University Corporation
- May 2021 Celebrated the 110th anniversary
- Sep. 2018 Completed the Ito Campus relocation
- May 2011 Celebrated the first centennial anniversary
- Apr. 2004 Launched as a National University Corporation
- Oct. 2003 Integrated the Kyushu Institute of Design
- May 1949 Established Kyushu University under the National School Establishment Law
- Jan. 1911 Established the Kyushu Imperial University
- Apr. 1903 Established the Fukuoka Medical College

Location



About Fukuoka

1,632,000 people

1st in population growth among Japanese cities

20 min. to beaches and mountains from the city center

Easily accessible from other major Asian cities through its international airport, Fukuoka is home to a rapidly growing number of startup companies in addition to national and prefectural governmental offices and many regional headquarters of major companies. Blessed with beautiful natural surroundings that can be enjoyed year round thanks to the mild climate, the area has flourished for approximately 2,000 years as a gateway to Asia and is now seeing an influx of foreign residents and students who come for business or study and stay for the natural scenery, long-standing traditions, great food, and warm-hearted people.

Students

18,560 undergraduate and graduate students

(As of May 1, 2022)

Enough students to fill the FUKUOKA PayPay Dome nearly halfway.

Number of students **18,560**

FUKUOKA PayPay Dome capacity 40,000

2,143 faculty, including 115 non-Japanese

(As of May 1, 2022)

9 : 1 student-to-faculty ratio

Providing education and research individually tailored to each student

Undergraduate Schools

Number of undergraduate students

Total	11,683	
	70% (Male)	30% (Female)
Interdisciplinary Science and Innovation	450	
	46%	54%
Letters	693	
	47%	53%
Education	208	
	36%	64%
Law	818	
	61%	39%
Economics	1,025	
	79%	21%
Science	1,174	
	84%	16%
Medicine	1,311	
	53%	47%
Dentistry	318	
	58%	42%
Pharmaceutical Sciences	397	
	63%	37%
Engineering	3,486	
	90%	10%
Design	840	
	63%	37%
Agriculture	963	
	57%	43%
The 21st Century Program	6 *	
	100%	0%

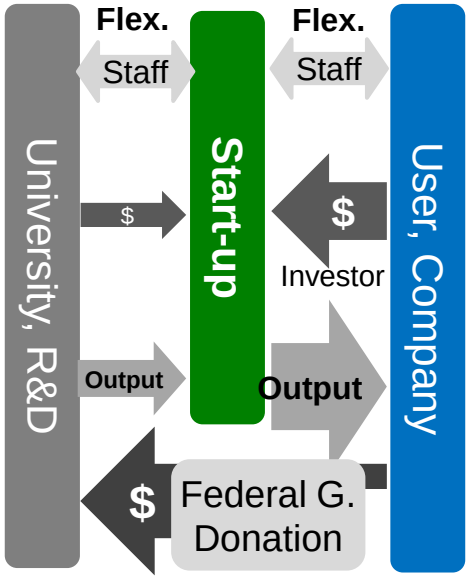
*The number of undergraduate students participating in the 21st century program

(As of May 1, 2022)

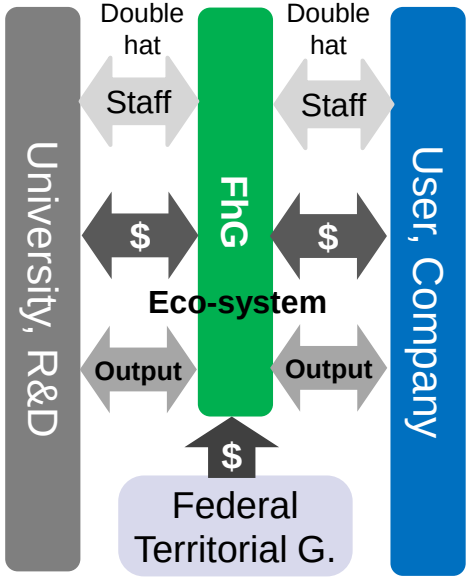
Support organizations to accomplish innovation

- **The US has a system for Start-up to deliver innovation.**
- **Fraunhofer is organizationally support for innovation.**

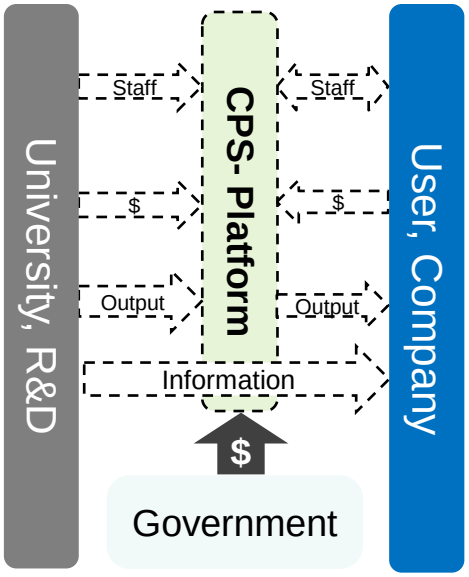
USA/ Start-up



Europe/ Fraunhofer (FhG)



Japan/ CPS Platform

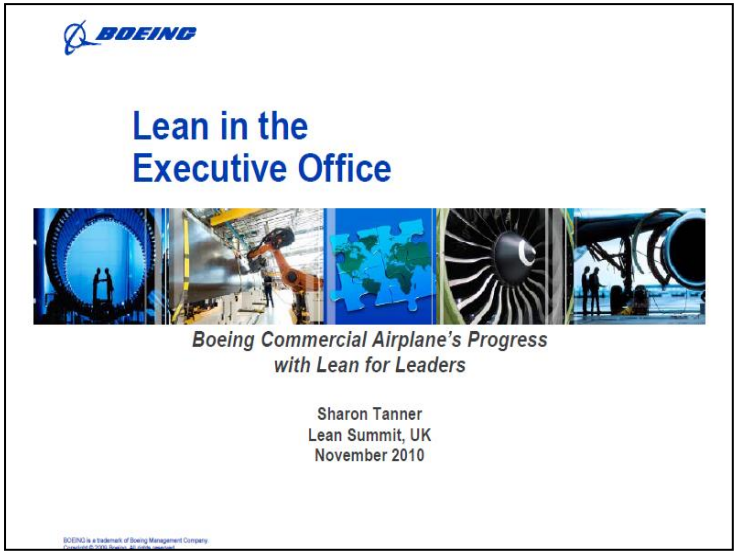


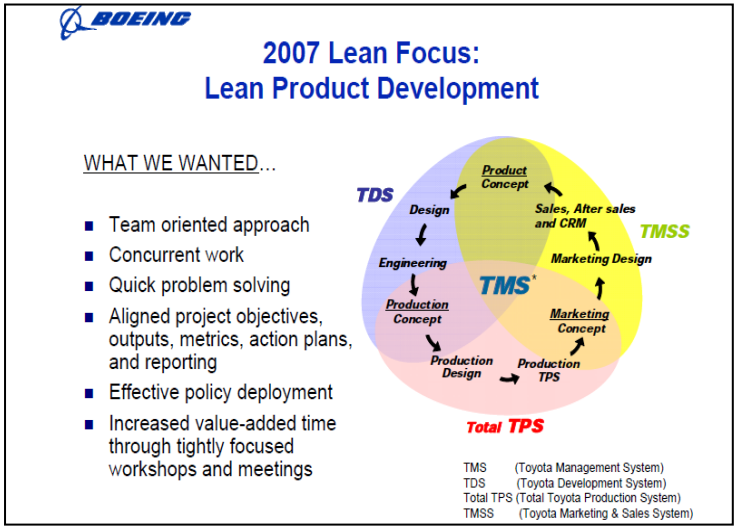
(Source)"Challenge to support smart society" by Mitsubishi UFJ Research and Consulting by Ogi, Toyo Keizai Inc. 2023, Revised Tanaka

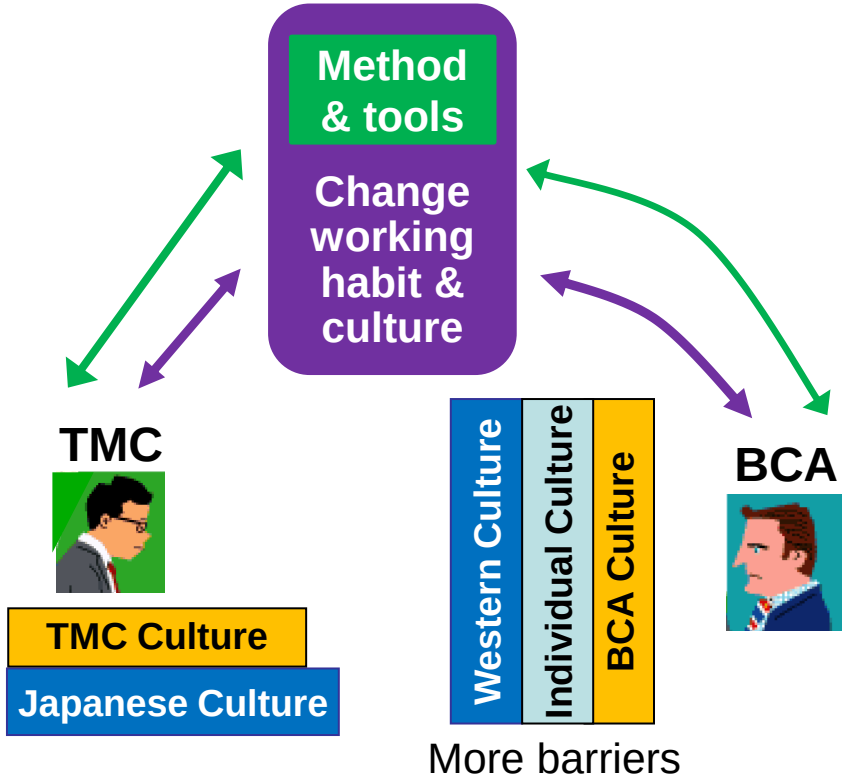
Agenda for today

1. Issue to start LEAN at Product development-phase
   - Case at BCA (Boeing Commercial Airplane)
2. Current hot topics
   - CPS-Platform
   - MBSE to accomplish AD (Auto driving) Level-4 & 5
   - New generation of data-center
   - Quantum computing
3. CPS-Platform for LPPDE

Case at BCA: Cultural barrier for learning together







(Source) Lean Summit 2010 - Sharon Tanner - Lean for Leaders in the Executive Office - Bing video
https://www.bing.com/videos/search?q=Boeing+Sharon+Lean&docid=603547921359534152&mid=099704F8804668F6CD3D099704F8804668F6CD3D&view=detail&FORM=VIRE

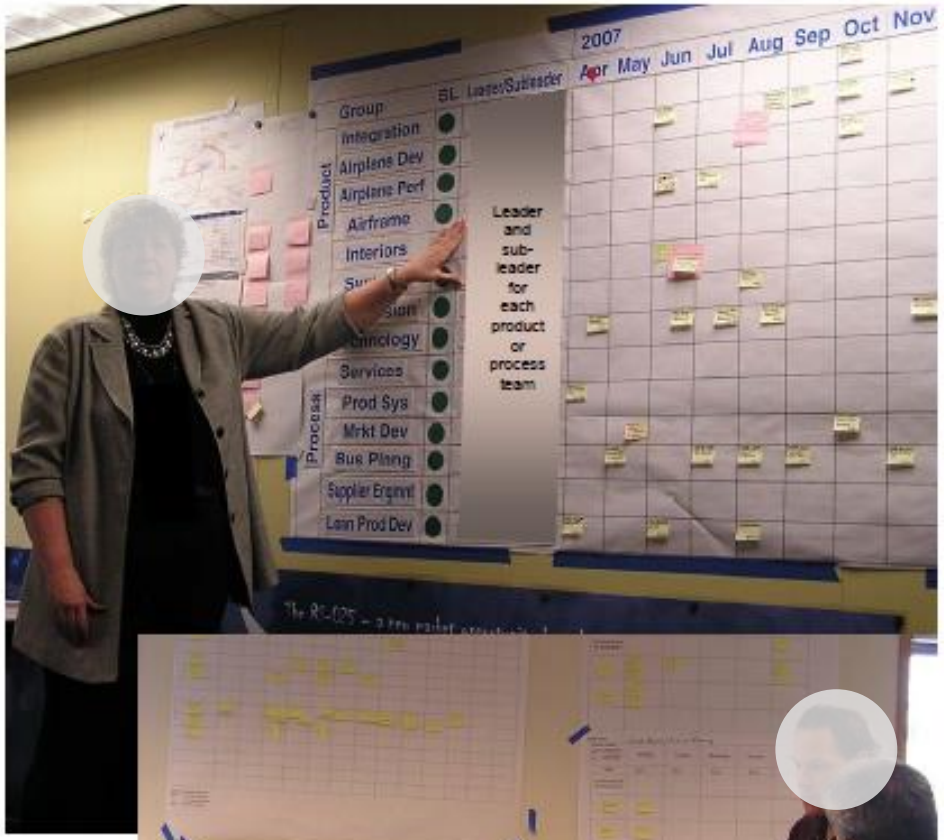
Case at BCA: Strong leader-ship for start

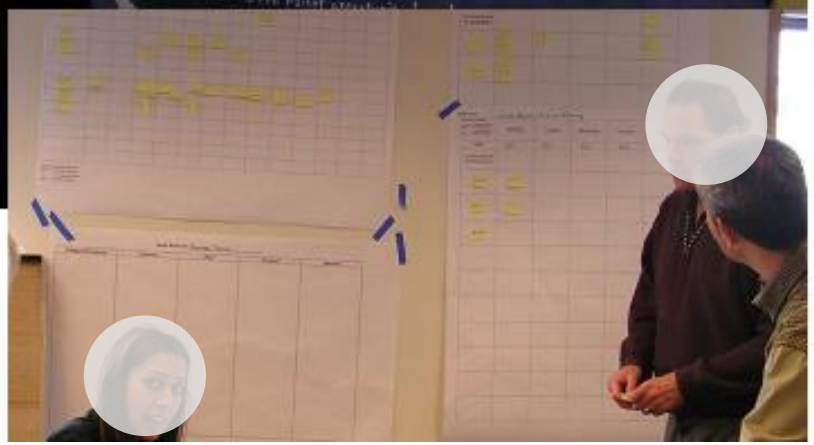
BOEING

PD Pilots Oobeya…

with consultants

- Kick-off
- Restructured Main Board
- Simple, visual format
- Few program targets to focus team effort
- Tiered implementation, engaging the whole team





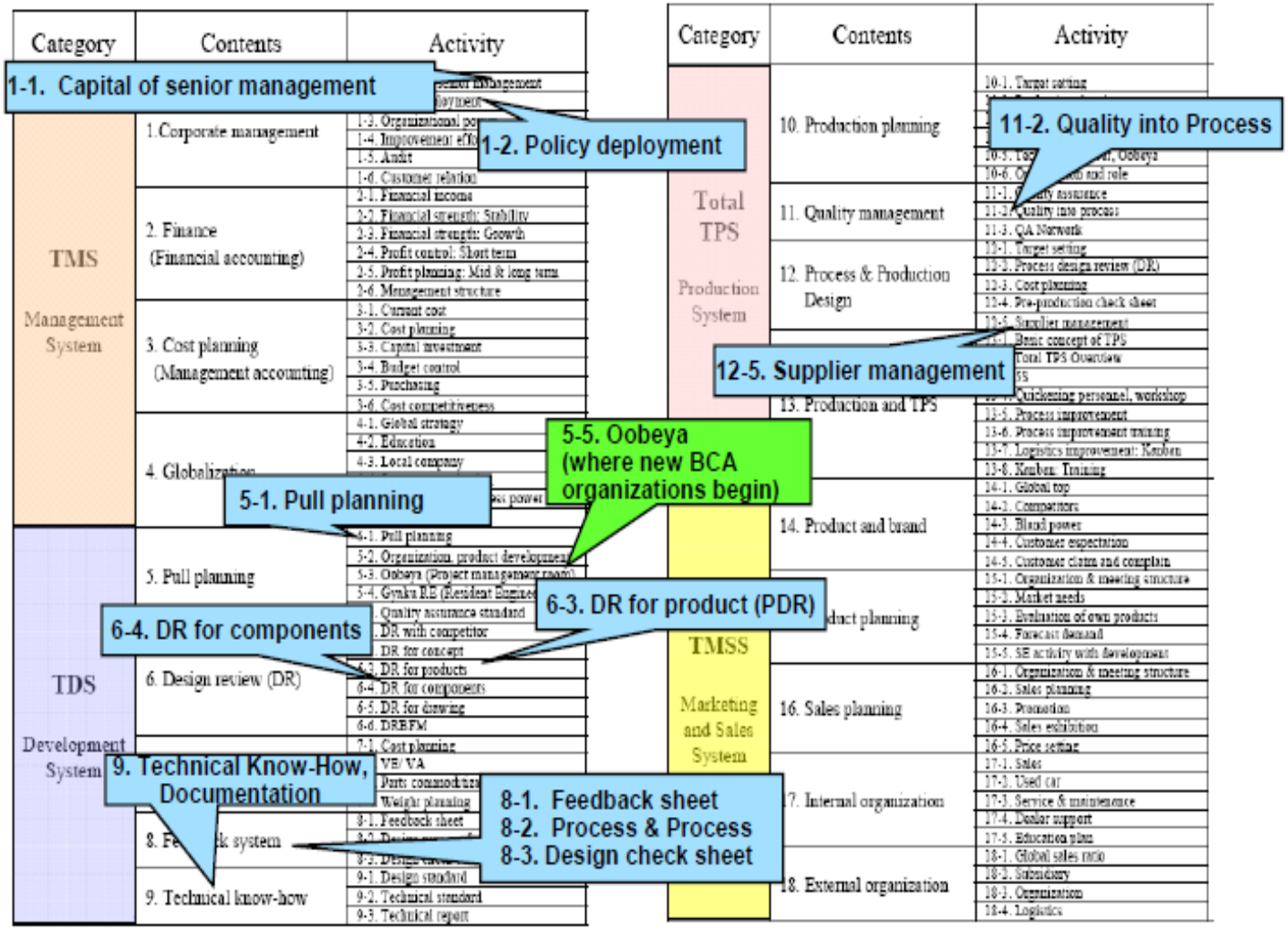
Lessons Learned:

- 3 levels of visualization
- Human-side of TMS system
- Value of the journey approach
- Depth gained from experiential learning

Case at BCA: Tools

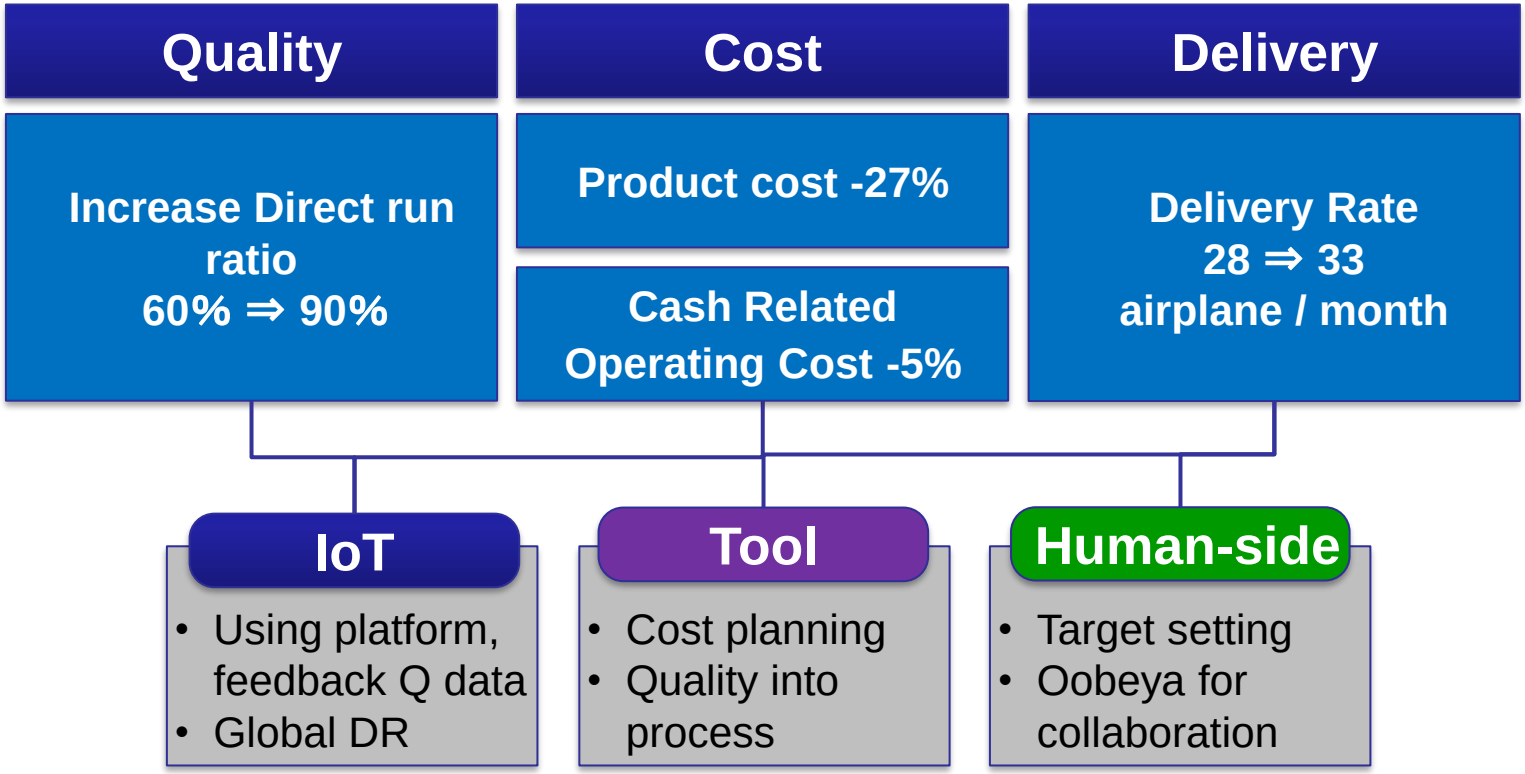
BOEING

A Comprehensive Toolset



Case at BCA: Target setting for B737 program

- **Focus target will be stated from D, and C, then Q is more accurately accomplished.**
- **Time is common measurement for everybody.**



Case at BCA: Words to change working habit & culture

- Kind targets
- Brain, not budget
- Sincerity is stronger than strategy
- Reflection

Oobeya transition to be Digital-twin

- **Kick-off phase is a physical Oobeya but transform to digital format within 1-year.**
- **Using PLM platform, global Oobeya execution is available.**

Kick-off

Company KGI/ KPI | Long-term Plan

- Just captured all KGI/ KPIs and difficult to prioritize
- Long-term plan has no collaboration between teams

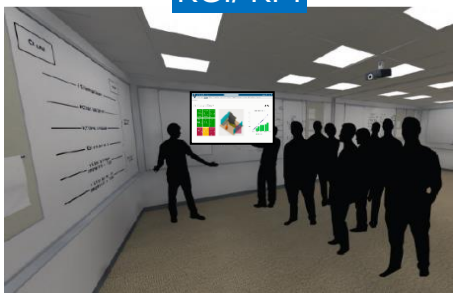
2-months

Company KGI/ KPI | Member KGI/ KPI | Long-term Plan

- Priority of company KGIs
- Members have start to decompose own KGI/ KPIs
- Long-term plan shows only critical mile-stones with output

1-years (Now)

Member KGI/ KPI



- The meeting is executing globally. Share KGI/ KPI and issues on platform.
- Discussions are still using physical wall to share real-time

Source: Toyota Engineering/ To improve productivity of airplane development using the techniques of automobile industry 2019

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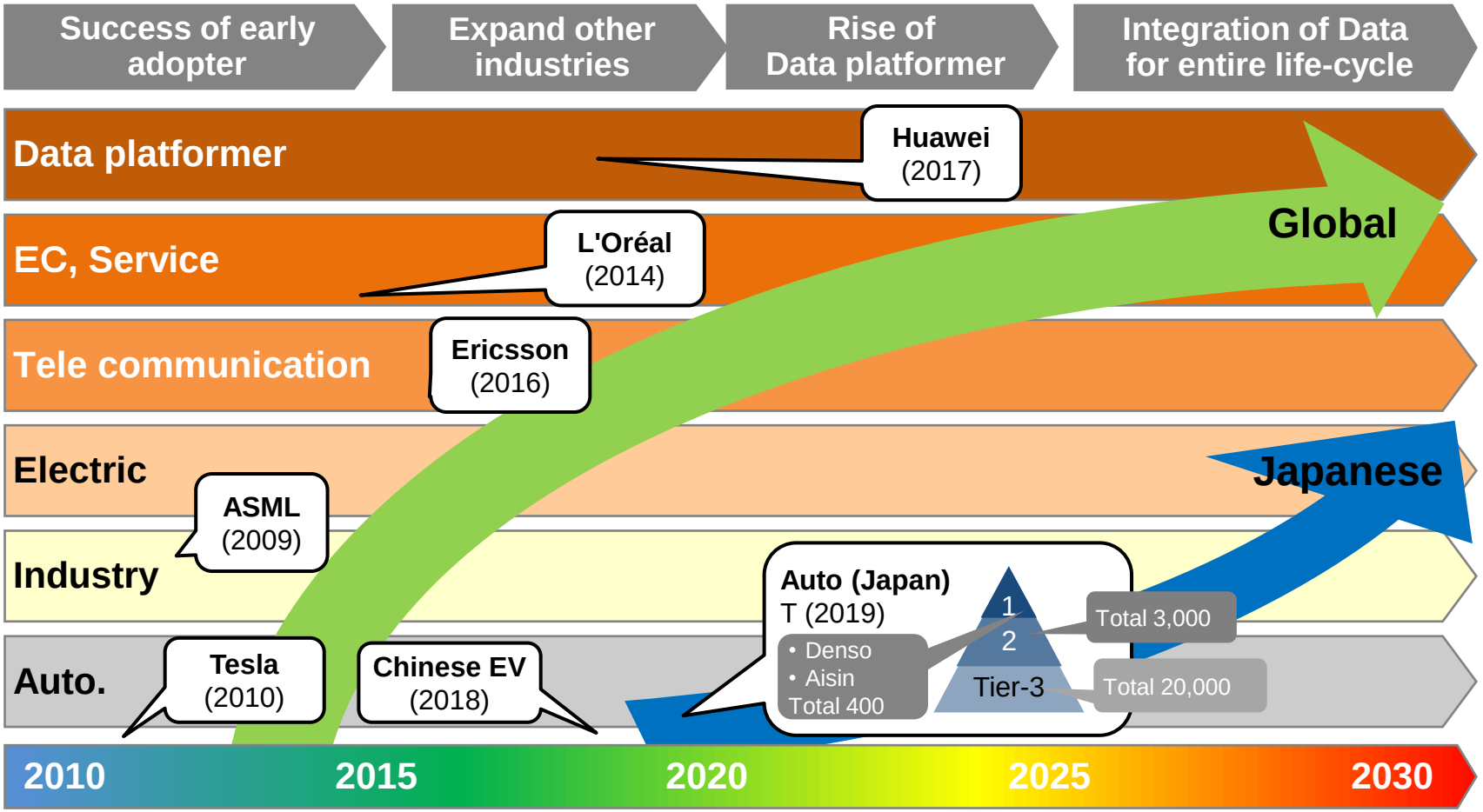
Using CPS-Platform, Companies are expanding the business

■ **Japanese OEM and suppliers have 10-years delay to invest.**



Source:
Huawai：https://www.huawei.com/jp/news/jp/2017/HWJP20170912M
L'Oreal：https://ifwe.3ds.com/sites/default/files/2017-12/cpgr-case-study-loreal-delmia-apriso.pdf
Ericsson：https://ifwe.3ds.com/ja/media/ericsson-and-dassault-systemes-partner-for-global-growth
ASML: https://www.plm.automation.siemens.com/global/ja/our-story/customers/asml/17256/
Tesla：https://www.3ds.com/ja/customer-stories/single/tesla-motors/#
T：https://prtimes.jp/main/html/rd/p/000000321.000006067.html

Design completeness at Cyber phase

- **Using V-process for product development, reduced workload consistently.**
- **Integration of mechanical, electrical and software integration.**

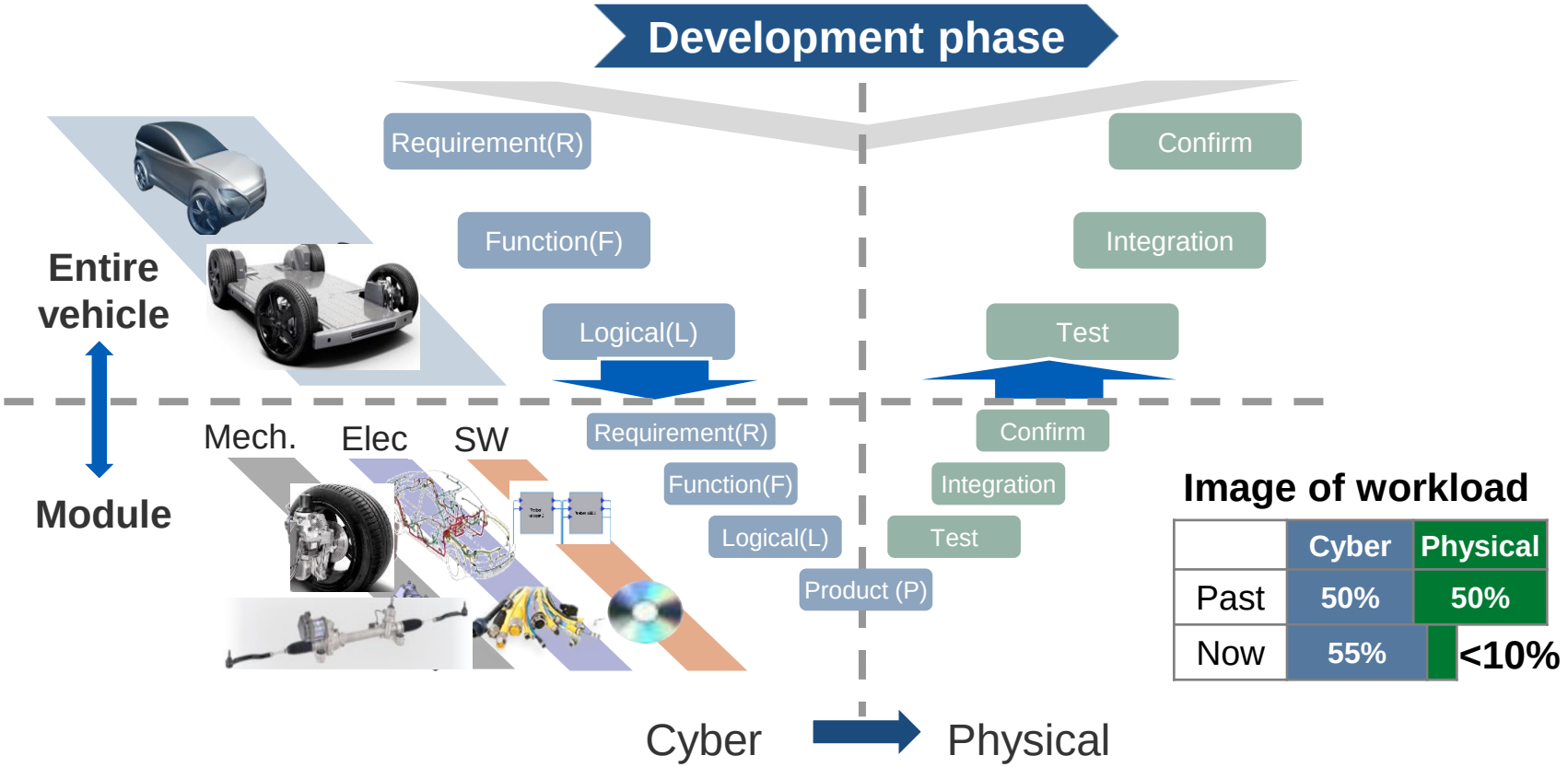


Image of workload

	Cyber	Physical
Past	50%	50%
Now	55%	<10%

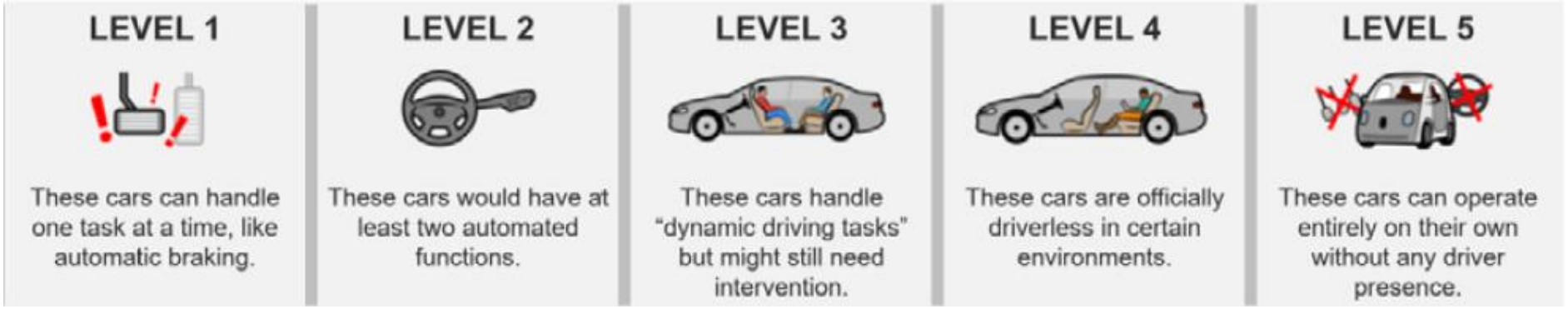
Source: REE- Automotive, Web-site

Tesla is using MBSE to accomplish AD (Auto Driving) Level- 4&5

- **Using CPS-Platform and MBSE, preparing for AD Level 4 & 5.**
- **Data management for AI/ML on Edge-AI, has necessary connecting with datacenter.**

Tesla is preparing

Other automobile firms

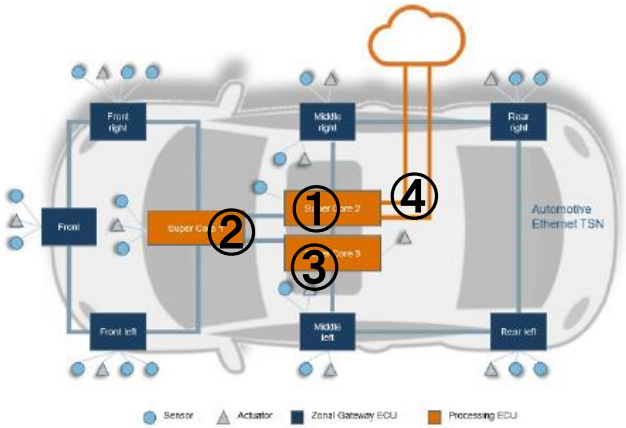


Source: System: Systems Thinking and Digital Transformation, Tesla case, Edited by Takashi
https://www.aras.com/ja-jp/resources/all/wp-systems-thinking-digital-transformation?utm_source=blog-aras&utm_medium=smm&utm_campaign=jp-systems-thinking-2020&utm_content=102798-wp-st-dx
https://www.businessinsider.com/what-are-the-different-levels-of-driverless-cars-2016-10
Tesla's New HW3 Self-Driving Computer,
https://cleantechnica.com/2019/06/15/teslas-new-hw3-self-driving-computer-its-a-beast-cleantechnica-deep-dive/

Complexity of ECUs for AD

- **Relied on many suppliers to develop ECU, there are more than 100s per vehicle.**
- **Currently ECU consolidated for 4-zones.**

CAR COMPETENCIES TURN FROM MECHANICAL TO SOFTWARE AND ELECTRONICS



ECU Consolidation into 4 main zones:

1. ADAS/Car Controller zone
2. Cockpit zone
3. Chasis/Motor/Engine zone
4. Connectivity zone

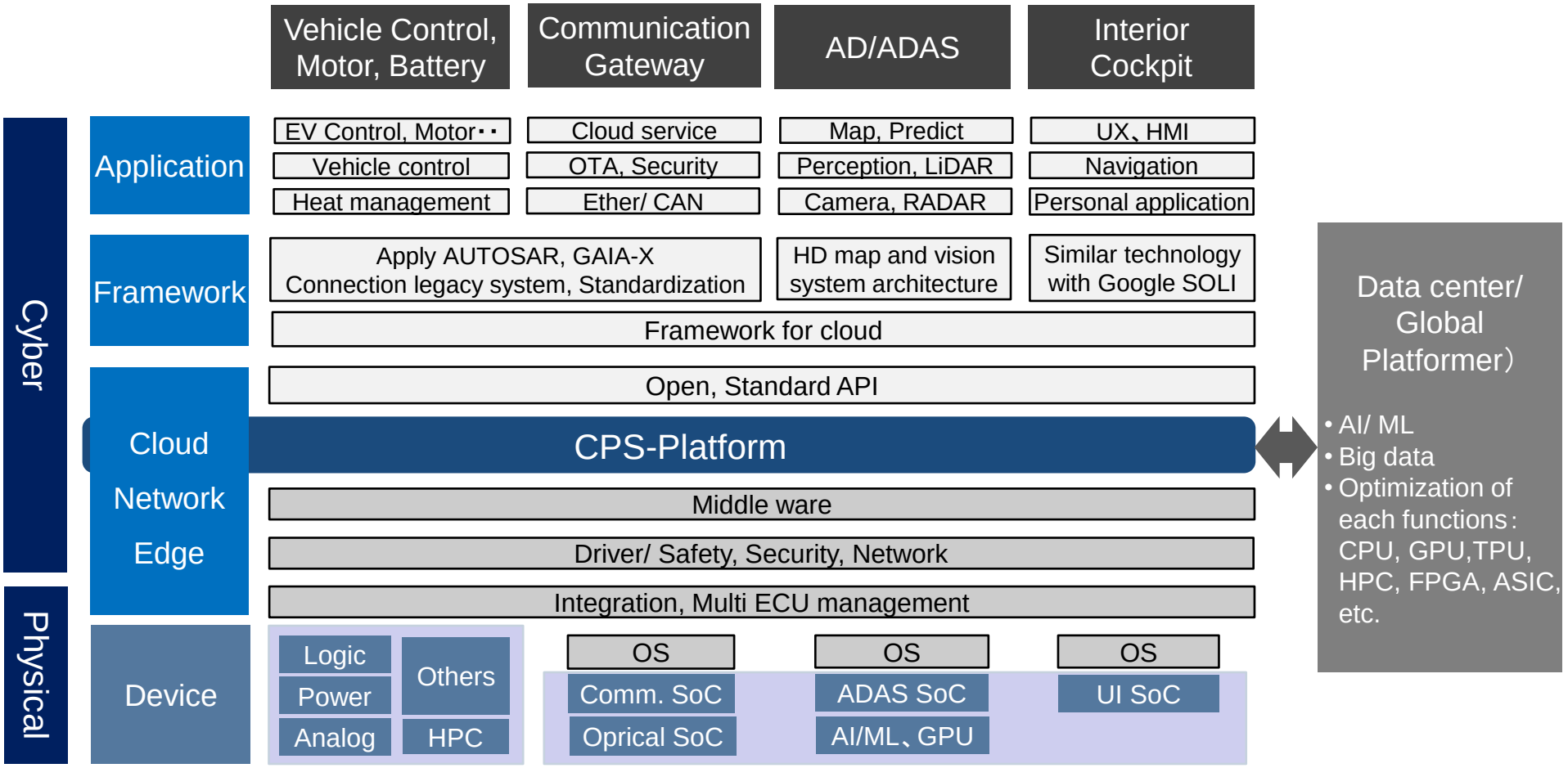
	SoCs per Function	Arteris IP Customers → ~42 SoC Design Wins
ADAS / Machine Learning / Car Controller *(1-4 systems per vehicle)*	2	Toshiba, NXP, BLACK SESAME, HAILO, Major Automotive EV OEM, BOSCH, Major ADAS System Maker, AutoChips, Major Design Services Co.
Vision Camera – Local Processing *(4-16 systems per vehicle)*	2	Toshiba, BLACK SESAME, nextchip
Dashboard / HUD/ DMS	2	NXP, RENESAS, sienqine, nuvoTon, ADERA
Infotainment	1	NXP, Major FPGA Company #2
Radar / Lidar	6	BOSCH, NXP, UHNDER, arbe ROBOTICS, vayyar
Chassis Control	4	
Engine/Motor Control	2	indie
V2X / V2I / WAN Modem / Gateway *(2-4 SoCs per vehicle)*	3	Silicon Mobility, SEQUANS, NXP
TOTAL	**22**	**Average of ~22 complex SoCs per electronically enabled vehicle**

Notes: Logos and company names are publicly announced Arteris customers

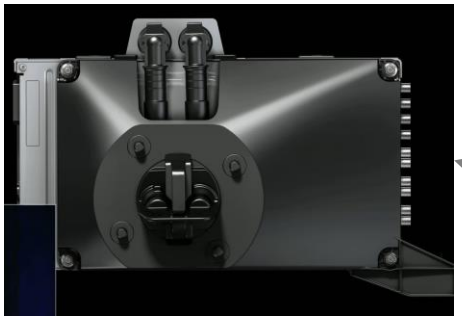
Source: LINLEY 2022 SPRING PROCESSOR CONFERENCEAPRIL 20-21, 2022, ARTERIS

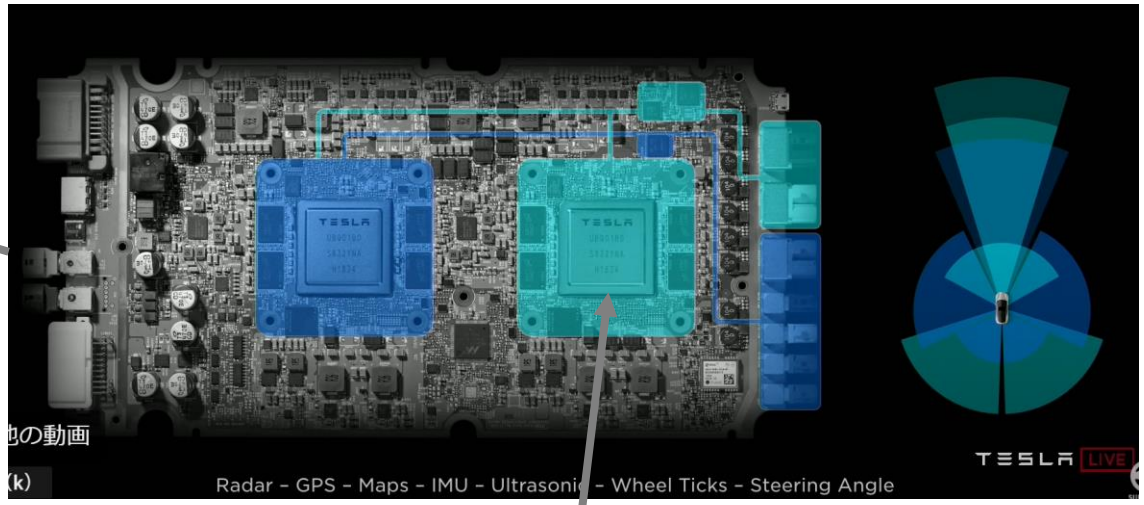
Technical Map of Auto Driving for AI/ Edge computing

- **For AI/ Edge computing architecture, there are the 4-zone architecture.**
- **Consider balance between data center and CPS-Platform for higher performance.**



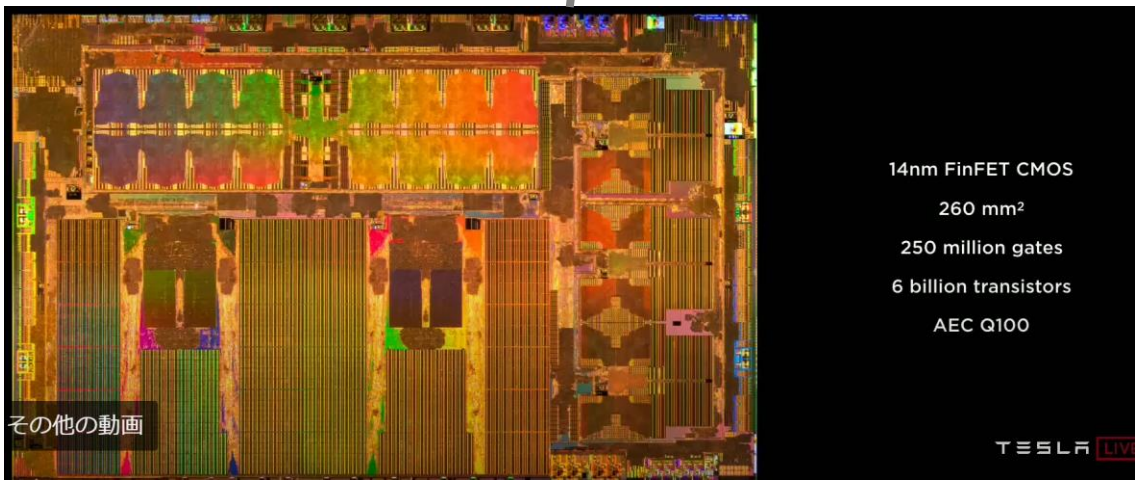
Tesla：Hardware 3.0 for training computer





Target：

- Attach inside glove box
- ＜100W: change current
- > 50TOPS for NN
- Batch size: GPU
- Security
- Dual redundancy



Source： https://www.autopilotreview.com/tesla-custom-ai-chips-hardware-3/

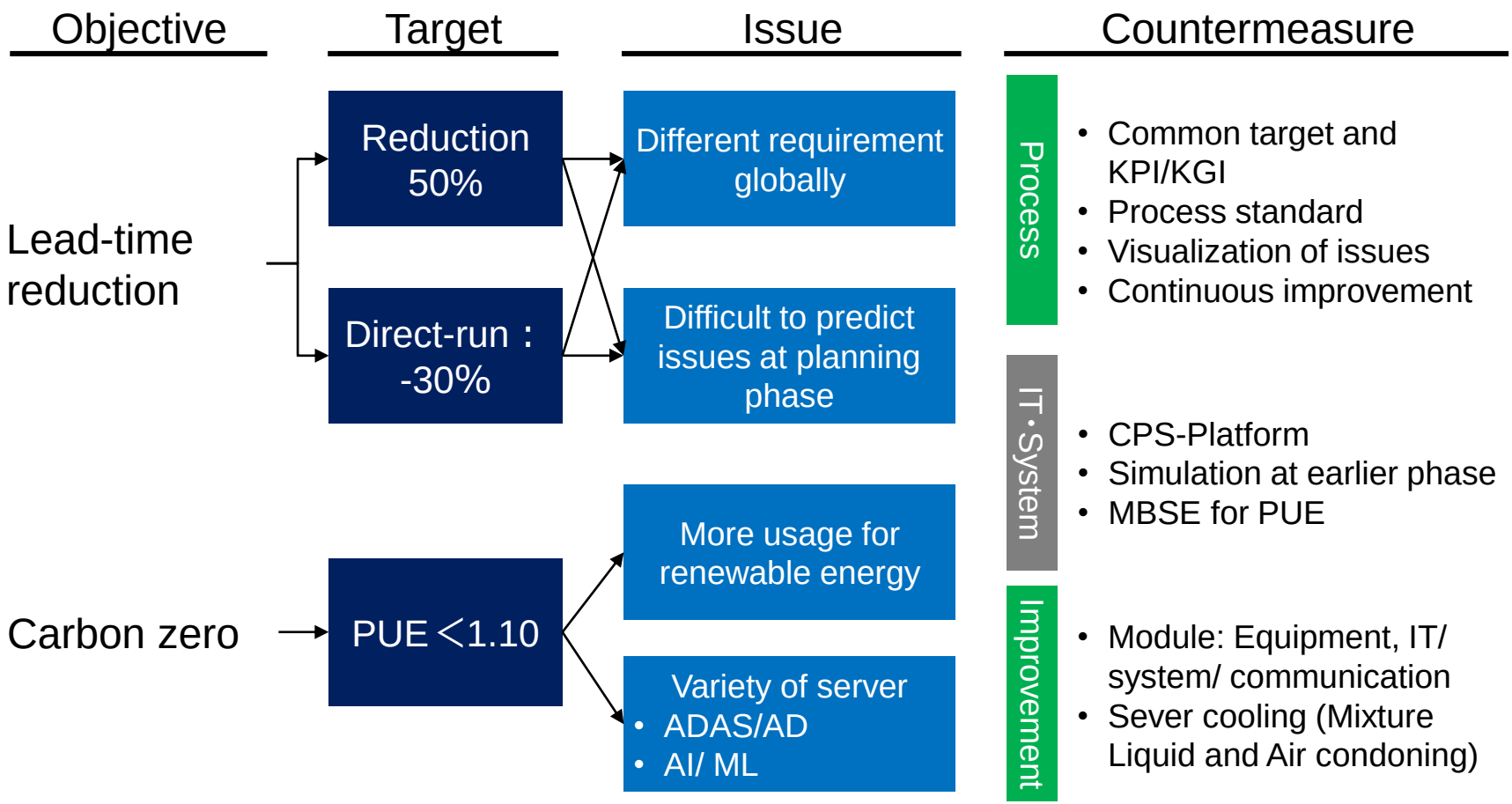
Next generation of data-center:

■ **Narrow role for local company.**

Lead-time/ Month		Planning →	42			→
			12	12	18	
Milestone		Concept	Design	Detail design	Construction Server room	Operation service
Business strategy	• Business assessment • Basic planning • Investment plan、ROI					
Construction	• Land, around location • Building structure • Server room・・・・		Design office →		Local company	
	• Electricity, UPS・・・ • Air-conditioning					
Operation process	• Planning−Operation STD • Target, KGI/KPI • Quality assurance・・・・					
Improvement	• Module: Construction • Module: System,/IT/Comm。 • Cooling					
IT System	• Server rack • Application • Middleware • OS • Server • Storage・・・・					

Next generation of data-center: Target setting

■ **Target and countermeasure of GAFA and BATH for next 3-years.**



Next generation of data-center: PUE explanation

- **Designing the “ideal state” to aim for zero carbon emissions.**
- **Add PUE goals and recommend process and system roadmaps.**

PUE : Power usage effectiveness
- Aiming for “1” is aligned with the zero carbon scenario

EF : Energy consumption from on-site fuels
Optimization to various circumstances locally

$$PUE = \frac{ESIS + EITS + ETX + EHV + ELV + EF}{EITS - ECRAC - EUPS - ELV + ENet1} = \frac{\text{Total facility energy}}{\text{IT equipment energy}}$$

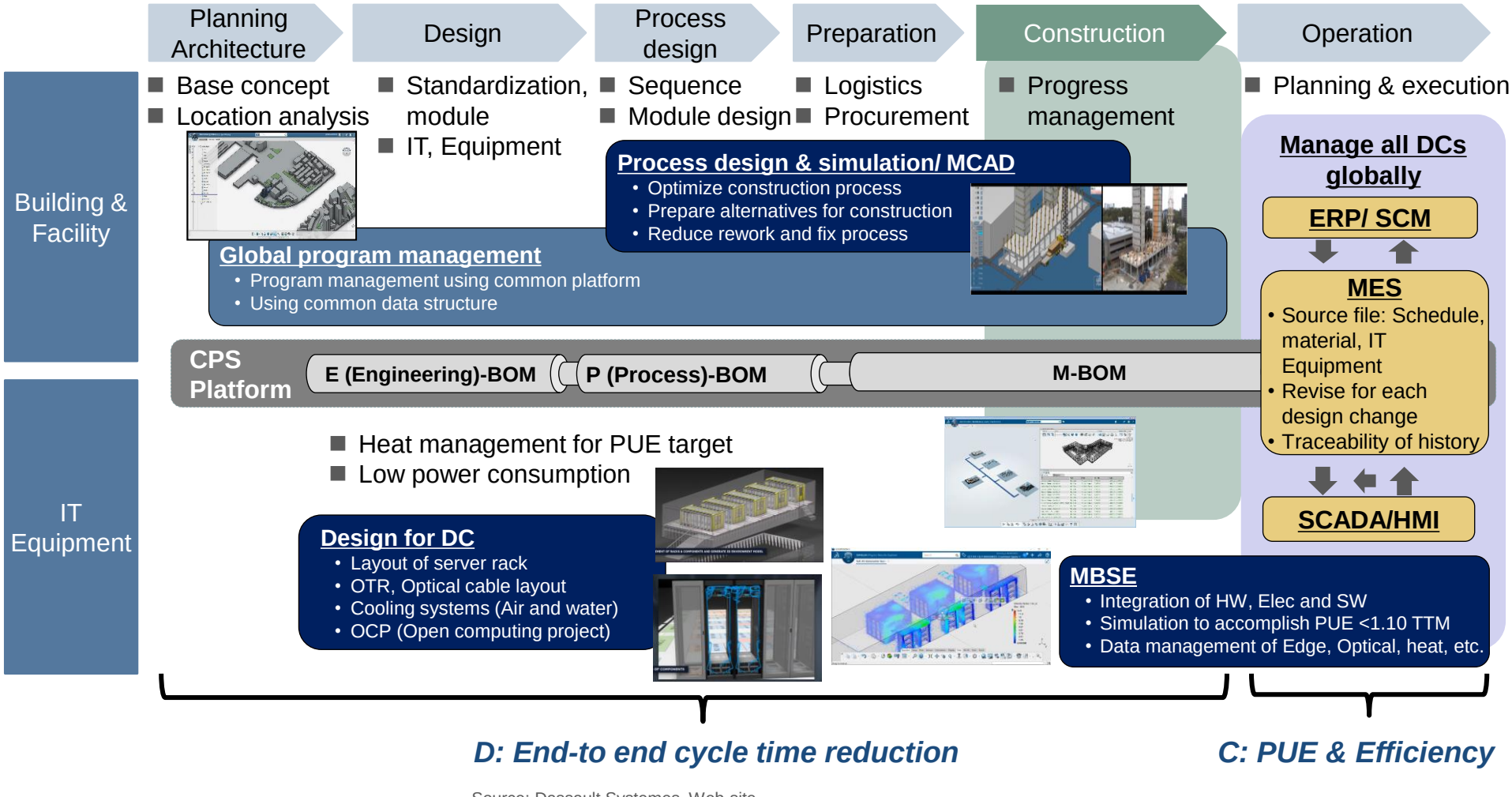
EITS : Energy consumption for IT power substations feeding servers, networks, storage, and computer room air conditioners (CRACS)
- PPA (Power Purchase Agreement) Simulation, execution, and feedback of cooling methods (combination of liquid cooling and air cooling) using MBSE

ELV: Low-voltage cable loss
- Server, network and storage communication methods and distance optimization. A server design is required to support CASE/AD. Optimization for CPU, GPU, TPU, HPC, FPGA, ASIC, Quantum Computing.

Remark PUE : Power usage effectiveness
ESIS : Energy consumption for supporting infrastructure power substations feeding the cooling plant, lighting, office space, and some network equipment
EITS : Energy consumption for IT power substations feeding servers, networks, storage, and computer room air conditioners (CRACS)
ETX : Medium and high-voltage transformer losses
EHV : High-voltage cable losses
ELV : Low-voltage cable loss
EF : Energy consumption from on-site fuels
ECRAC : CRAC energy consumption
EUPS : Energy loss at uninterruptible power supplies (UPSes) that feed servers, network, and storage equipment
ENet1 : Network room energy fed from type 1 unit substitution

Using a common platform for entire life-cycle

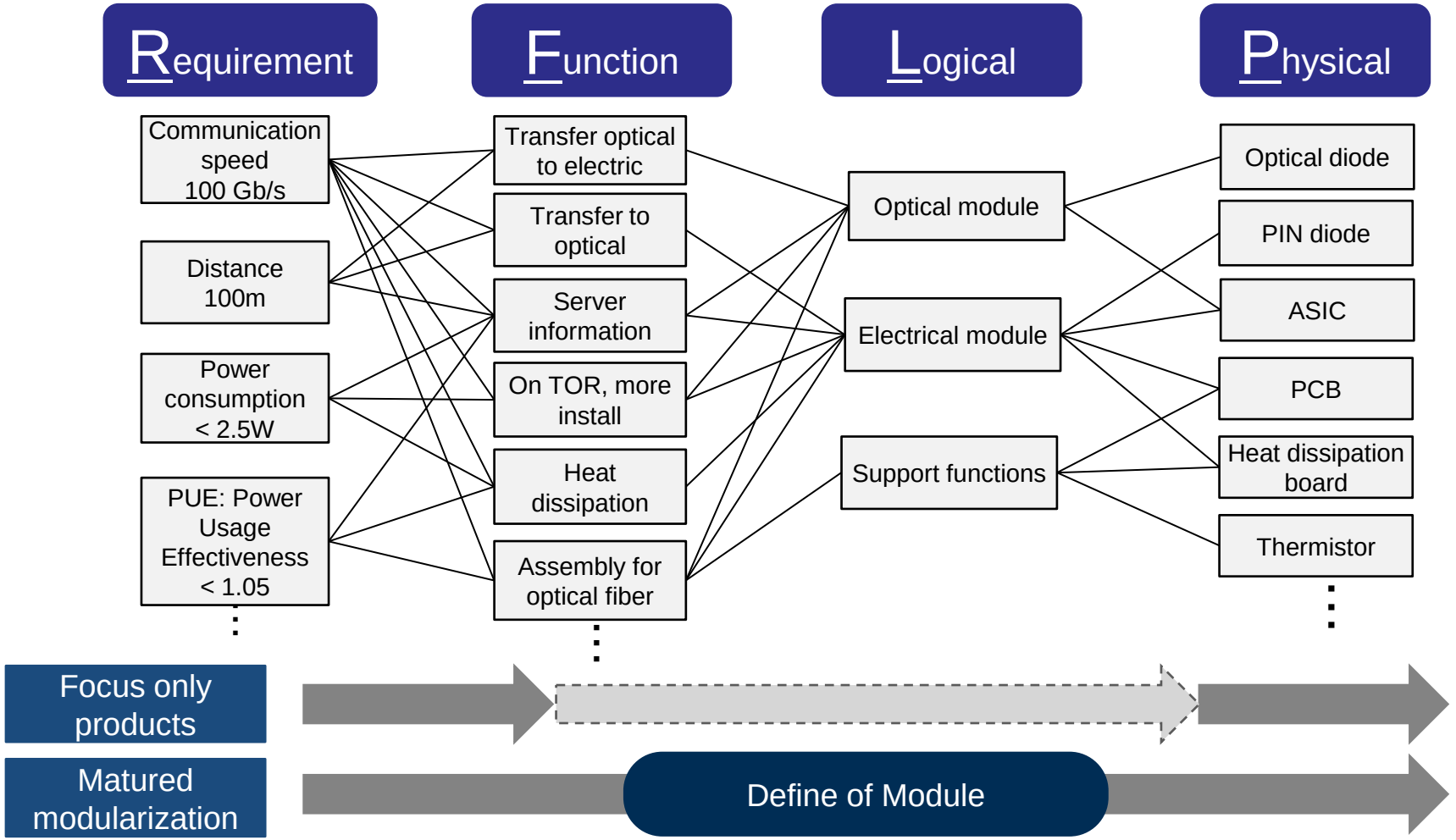
- **CPS Platform supports sustaining operations for global projects.**
- **Collaborative development between building & facility and IT equipment.**



Source: Dassault Systemes, Web-site

MBSE: Applied for data center/ Optical transceiver

- **Early phase of Modularization, focus only for products.**
- **After RFLP development, Modularization would be real value.**



Quantum Computing with Current computer

- **Current and quantum computers are hybridized and implemented in society.**
- **Quantum annealing has started to get the results in social implementation.**

Category		HW	SW/solutions	Social implementation
Current Computer • Logic/Arithmetic	**Current semiconductor**	• GAFAM • BATH • Global platformer	• Manufactures: Automotive, semiconductor, industry equipment, etc. • Data-center • AI/ML, Telecommunication	Expanding
	Quantum annealing	• D-Wave • NVIDIA • (NEC)	• Optimization, QAOA • AI/ML	
Quantum Computer • Specific problem solving	**Quantum gate** Superconductivity Ions, Light, Si	• IBM, Google • Rigetti, IonQ Honeywell	• VQE、NISQ • Quantum chemistry＋VQE	10 years later
	Light/ Quantum communication	• Toshiba	• Encryption • Security	

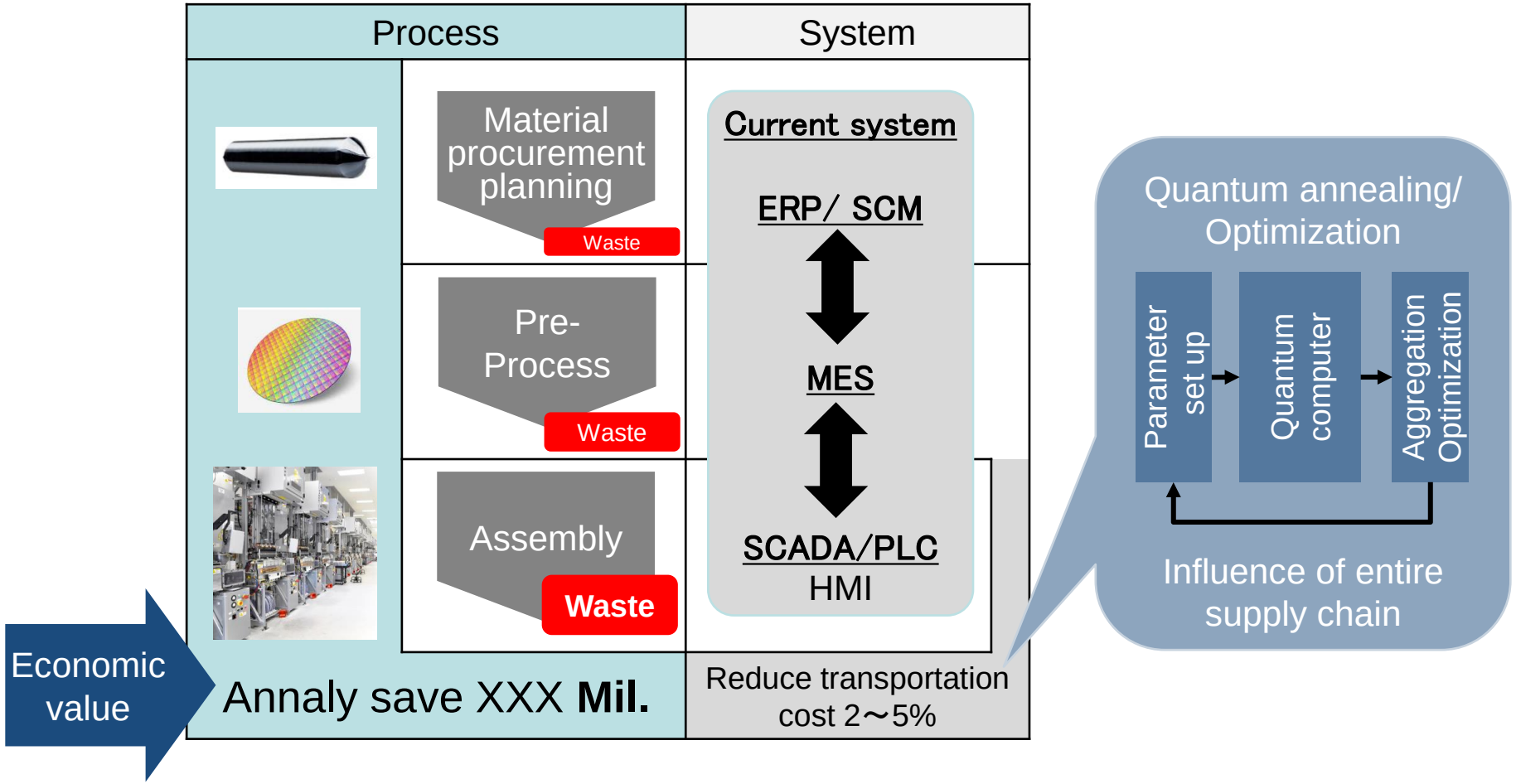
CPS: Cyber physical systems
PLM: Product life-cycle management
MBSE: Model based system engineering

QAOA: Quantum approximate-scale algorithm
VQE: Variational quantum eigensolver
NISQ: Noisy intermediate-scale quantum

Estimate of the final impact of outcome

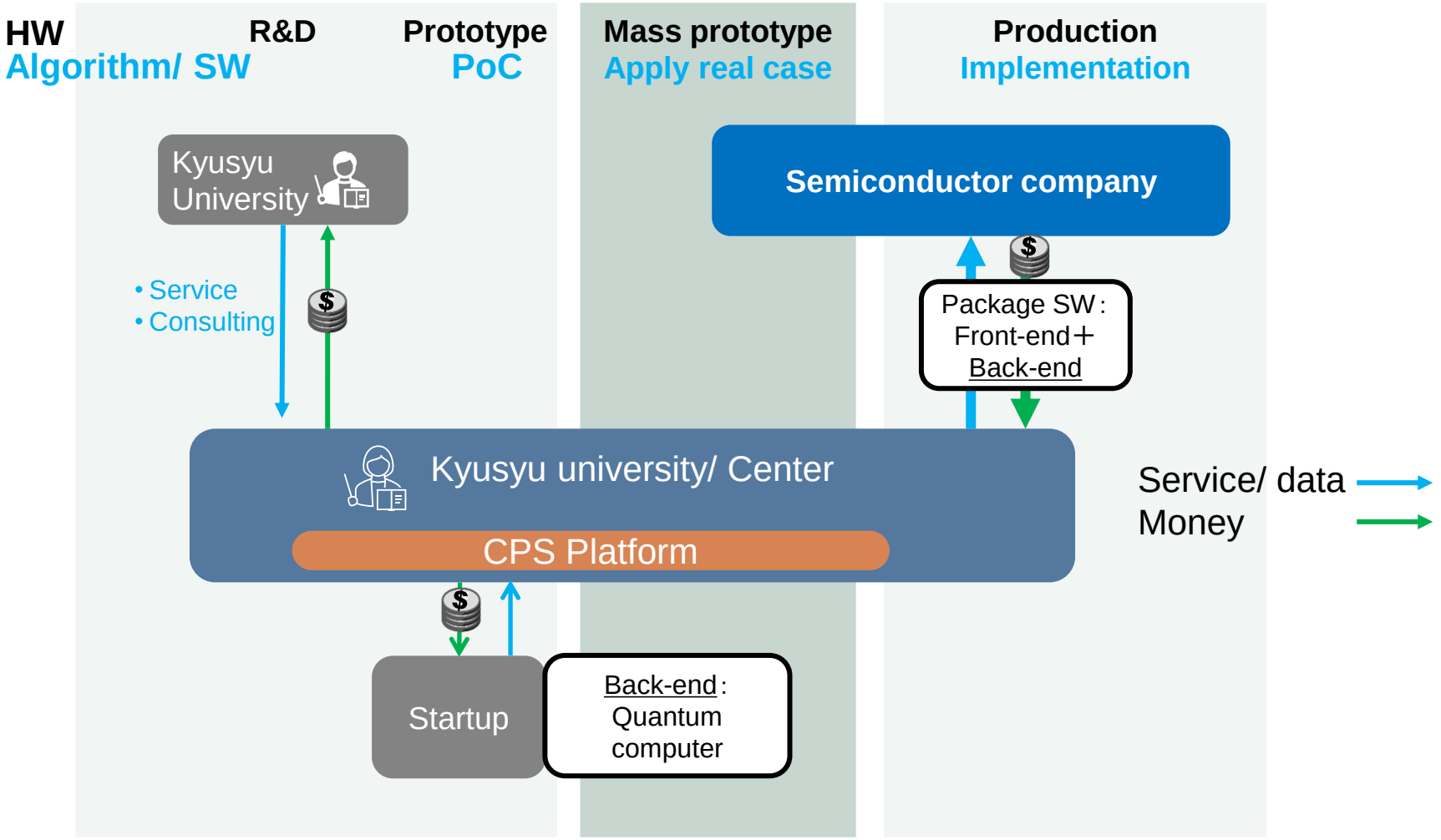
■ **Estimate the value using Quantum computer, to fit industrial phase.**

Supply chain/ Production phase of silicon wafer



Eco-System for Quantum annealing

- **The package software to a semiconductor company and get income.**
- **Establish a suitable development center inside of Kyusyu University.**



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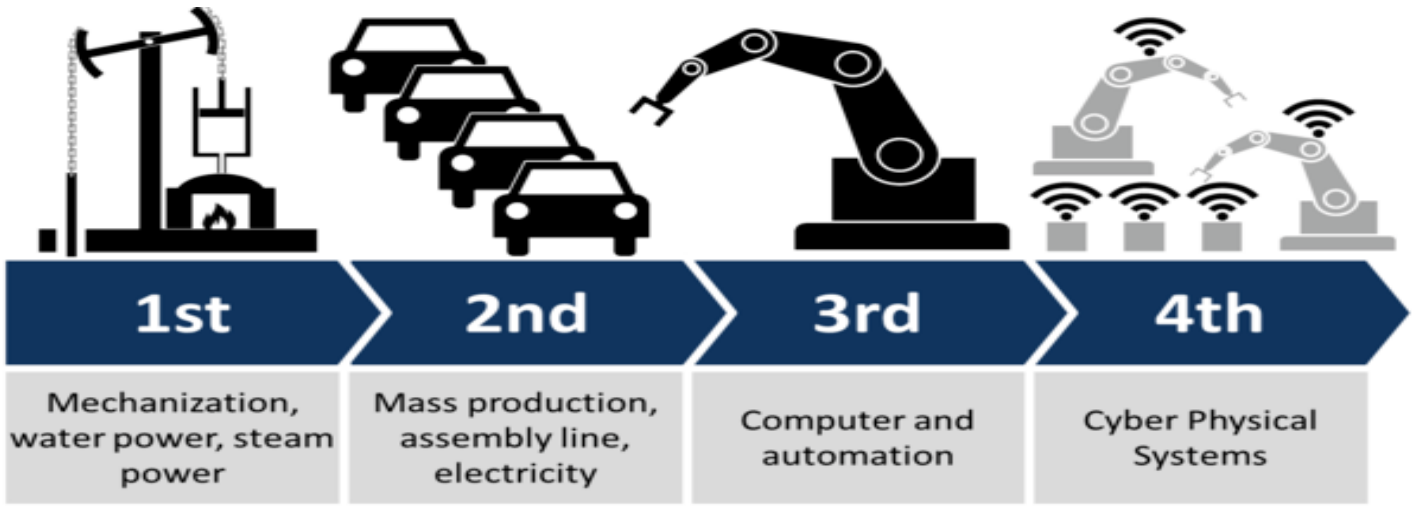
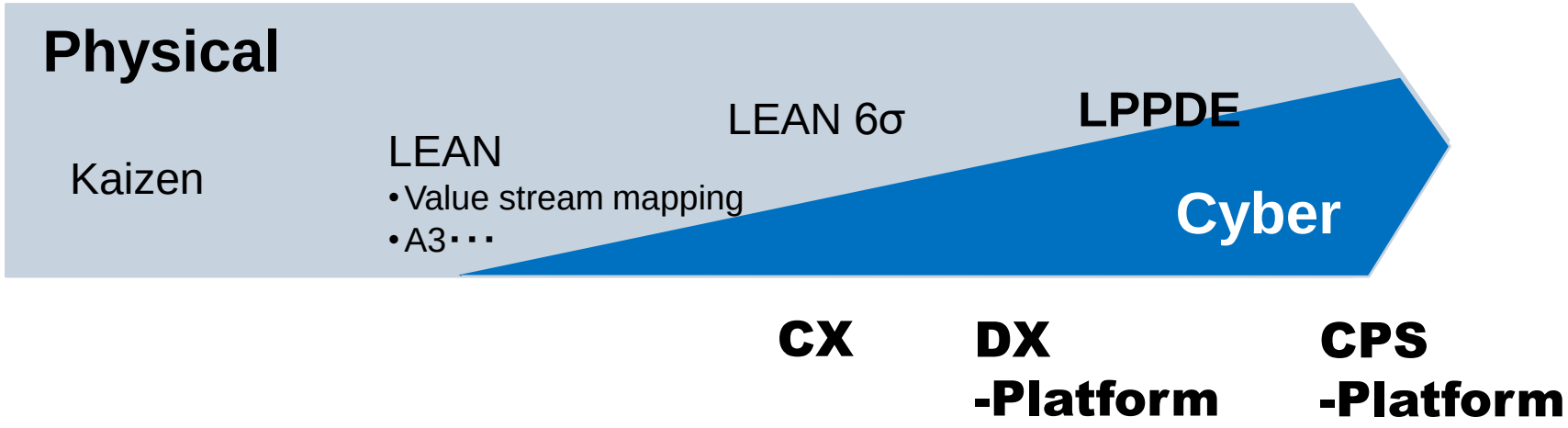
CPS-Platform is necessary for LPPDE





Conclusion

Learning

- Process & tools from Japan
- Framework from Europe
- IT/ System from US

Integrate in your LEAN Product Development!